Overview of use of Red Mud in Construction Sector

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Abstract:- *After water, cement is the material that is used the most on planet. Cement, fine and coarse aggregates, coarse aggregate, & liquid are the main ingredients. Numerous research have been conducted on the use of red mud in the production of various industrial goods, including ceramic tiles, bricks, cement, and land reclamation. This essay examines red mud's use in general. This report also examined Red Mud's function in the construction industry. Additionally, we have supplied a literature review of many researchers working in the construction industry.*
Keywords *Red Mud, Construction Sector, Bayers process*

I. Introduction

After water, cement is the material that is used the most on planet. Cement, fine aggregate, coarse aggregate, and liquid are the main ingredients [1]. based on data from 2012 to 2017. India produces more than 270 million metric tons of the nearly 4000 million metric tons of concrete generated yearly worldwide, ranking second in the world in terms of contribution. Because one ton of clinker provides one ton of CO2 emissions in the atmosphere, co2 is one of the principal atmospheric pollutants emitted by enterprises that produce cement. Some industrial by-products like FA, GGBS, RHA, SF, and many others are used as secondary cementitious to reduce pollution brought on by the manufacturing of concrete. Alumina refining plants make red mud, a highly alkaline solid byproduct. The Bayer processing or sintered method used to produce alumina typically results in red muck. It comes in the form of a slurry and contains a lot of sodium aluminosilicate.

More than 300 million tons of red mud are produced worldwide each year by the aluminium industry. Large amounts of red mud are particularly hard to decompose of, and doing so pollutes the land, the air, and the water. due to the fact that it has a high alkaline nature and is filled with dangerous materials including metals and radioactive materials. Red mud weighs between one and five tonnes each ton of alumina produced. The amount of red mud that is wasted depends on the bauxite ore and refining procedure. Numerous research have been conducted on the use of red mud in the production of various industrial goods, including ceramic tiles, bricks, concrete, and land reclamation.

Red mud is additionally utilized as an absorbent in the treatment of water and exhaust gas. Adsorbents are employed in businesses to recover dangerous minerals from both organic and inorganic substances.

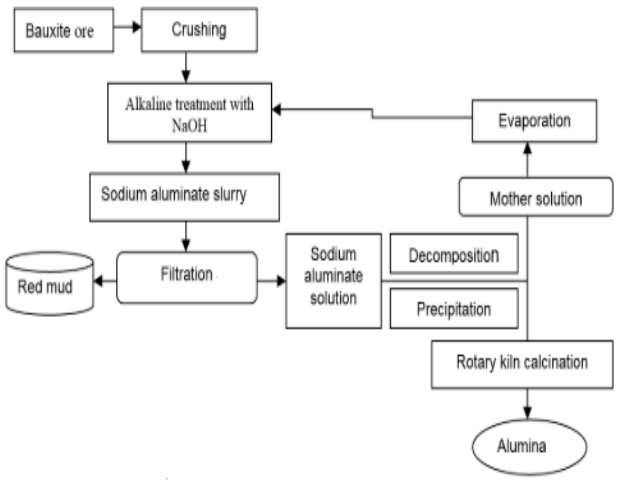

Figure 1 Bayer process

The search for innovative construction materials that can completely or partially replacing some traditional natural construction materials has grown quickly in recent years. In that situation, mortar and concrete composite structures are the most attractive materials. Since both materials consist of at least three different parts, aggregates or binders is the subject of investigation.
Utilizing industrial waste products which are no longer in use in the manufacturing of cement or directly in the creation of concrete or mortar is one of the suggestions [3]. Two factors—waste material particle size and chemical composition—justify this [4]. Existing cement manufacturing processes use materials like fly ash and silica fume as cement additives in concrete and mortar. Red mud is one of the advanced materials that has come into attention in recent years. Red mud is a by-product of producing aluminium in factories using bauxite ore as the primary raw material.

II. Red mud in construction sector

Red mud is a solid waste material left over after bauxite ores were digested with caustic soda to produce aluminium. When it associated with environmental considerations, its disposal is still a problem on a global scale. Many researchers have worked hard over the past few decades to discover a variety of profitable ways to use red mud. Utilizing red mud in the manufacture of cement is one of the more cost-effective methods and an effective approach to recycle red mud on a wide scale.
A solid waste product from the processing of bauxite into aluminium is the red mud. As depicted in figure 1, the procedure is known as the "Bayer process" and consists of four key steps: digesting, clarity, precipitate, and carbonization. In order to digest, a granulometric decrease ofbauxite. The bauxite is submerged in a sodium hydroxide solution during the clarifying stage to separating the aluminium and impurities (red mud). When alumina is subjected to temperatures high than 960°C, precipitation enables removal and calcination of the alumina. The following step is the reduction reaction, in which the aluminium is converted by electrolytic processes into aluminium. The red mud's alkalinity qualities and presence of some heavy metals are caused by the hydroxide solution. The majority of the researchers classified the red mud as a harmful waste for the environment .consequently of this property. On the other hand, other studies categorize red mud as non-inert waste. Disagreements in red mud classifications are caused by various standards and laws that have been implemented, as well as by the many locations where bauxite is harvested, where its composition and chemical components may alter over time. Even quantities of red mud produced in the same business can vary depending on the techniques of production.

III. Literature review

(Agrawal &Dhawan, 2021) Red mud is a type of industrial waste produced during the manufacturing of alumina that contains leftover minerals from bauxite ore. It is a possible polymetallic source because of the significant metallurgical values and notable concentration. Red mud is currently managed by either dry stacking in open spaces or storage in man-made ponds or dams, both of which are expensive and environmentally risky. Red mud has recently been used to make cement, although doing so leads in the loss of important minerals, which could be strategically beneficial for countries with limited resources. Utilizing red mud to create concentration can lower industry liabilities and have a positive impact on the environment while also considerably increasing the efficiency of the aluminium process of production. To recover metal elements from the red mud and ensure low waste production, an integrated approach is suggested.

(Hertel & Pontikes, 2020) In-depth analysis of the growing literature on alkali-activated binders from BR and wasted Bayer liquor, another potential resource from an aluminium refinery, is provided in this article. Additionally, a determination is made regarding the potential contribution of these resources to alkali-activated materials. The review approaches the subject from the standpoint of an aluminium refineries, summarizing and analyzing previous work while also synthesizing these efforts into a framework that highlights both the opportunities and the difficulties.

(Khanna et al., 2022) A significant environmental and ecological problem is how to manage red mud (RM), a solid waste byproduct of the aluminium process of recovery. With over 150 million tons of RM produced annually on a global scale, there are already 4.6 billion tons of RM in massive waste deposits. Radioactive elements, minor elements, and minerals can all be found in significant quantities in RM. This study evaluated RM's suitability as a low-grade iron resource.

(Qaidi et al., 2022) A general summary of RM's physical and chemical characteristics, production, distribution, categorization, and prospective applications is provided. In addition, new developments in the use of RM and slag for the creation of geopolymers are discussed in terms of their physical, mechanical, durable, and microstructural characteristics. Additionally, this study tries to outline a path toward a realistic valuation that takes into account both real and perceived issues, like radon, leaching, and the evaluation of the red mud geopolymer's life cycle (RM-GP).

(Joseph et al., 2020) examines the present initiatives undertaken to use red mud as a valuable industrial by-product, that should lessen its negative environmental impact. The numerous unique uses of modified red mud as a coagulation, an adsorption for treating wastewater, as well as its use in catalytic reactions and in construction materials, are compiled and

highlighted in this thorough review. A variety of treatment processes, including as acidification, neutralizing, and thermal treatment, can be used to adjust the physical properties characteristics of red mud.

(Muraleedharan & Nadir, 2021) a review of studies that use RM and GW to create geopolymer mortar and binders This paper provides an overview of the parameters that affect the mechanical and microstructural behavior of RM and GW cementitious materials, including curing time, workability, the effects of alkaline liquid types, concentrations, molar ratios of various chemical compounds, liquid to solid ratios, fine aggregate to binder ratios, curing conditions, addition of plasticizer, and other admixtures.

(Singh & Kamboj, 2020) Red mud is a type of industrial waste produced by the Bayer Process when alumina is made from bauxite. The purpose of the work is to analyze compressive strength according to the age of the concrete structure using an ultrasonic pulse velocity method. These industrial trash hold some significant weights. The compressive of a young concrete building can be approximated at the site of residential development, and the compressive strength of an existing building can be approximated at the site of remodeling, if a correlation between the ultrasonic pulse velocity and compressive strength as according age is found. The estimating equations verified that using noninvasive test methods, it is possible to estimate the compressive strength of the concrete according to its age.

(Silveira et al., 2021) gives an assessment of the production of aluminum, highlighting the value of the metals, its global production, and the impact on the environment of the manufacturing process. It provides a summary of the prospective uses for red mud by highlighting its overall production, some pertinent characterization findings gleaned from the literature, and its application in several engineering fields. The goal of the study was to identify areas where red mud features would be advantageous.

(Zhang et al., 2021) This essay makes an effort to review current studies on the use of red mud as a pavement materials in literature, covering road bases and asphalt blends. Prior laboratory studies suggested that red mud could be used as a raw material in road bases with acceptable unconfined compressive strength (UCS), temperature resistance, and based on embedded, but it is still unknown how durable these materials will be over the course of the pavement's service life.

(Reddy et al., 2021) With the help of a thorough literature review and in-depth laboratory investigations on Indian RM, the study's authors set out to critically evaluate current knowledge of RM's properties. They then sought to assess and identify possible engineering applications and discuss associated difficulties with using RM in real-world settings. Review of the physical, chemical, mineralogical, and geological characteristics of RMs from various origins and production procedures.

(Lima et al., 2017) By concentrating on two key areas—cement production/ceramic materials and road building—this study aims to assess the potential applications of red mud in the construction sector. Background information from previous researchers was taken into account and examined for technological, economical, and environment viability.

(Kumar et al., 2021) The usage of ingredients such fly ash, ground granulated blast furnace slag, silica fume, metakaolin, waste mudstone, and rice husk ash by RM to create composite material and AAB samples is highlighted in this article. The geopolymer contained the heavy metal ions in their residual and oxidizable fractions, which improved stability and eliminated a serious environmental concern from the supply chains' weak acid-soluble and reducible portion.

(Ćećez et al., 2021) give an overview of the studies on the use of red mud as a substitute for cement in mortars and concrete. Red mud is an intriguing possibility for study efforts globally, despite the fact that it cannot entirely be regarded as artificial pozzolan. The impact of the cement industry would be lessened by partially substituting raw materials or cement, given how much it contributes to environmental degradation. Technology for making mortar and concrete with the inclusion of red mud would help to build sustainable and environmentally friendly products.

(Venkatesh et al., 2019) The physical and chemical characteristics of red mud, as well as the Bayer method, were critically reviewed in the current research. Additionally, red mud's characteristics as a sustainability cement content when utilized in concrete include workability, mechanical durability, and microstructure. Iron oxide and aluminium oxide are both widely distributed in the red mud. Red mud speeds up the heat of hydrolysis in concrete, which increases strength early on. Concrete's workability decreases as red mud content was increased, while its strenghtincreases.. However, the chemical makeup of red mud and the size of its particles contribute to the strength of concrete. Red mud is more able to stop the diffusion of chloride as well as other ions into concrete. Due to the size of its particles and ability to connect with other minerals up to a particular dosage when used in concrete, red mud reduces the number of microscopic cracks and voids that are present.

IV. RM WASTE MANAGEMENT STRATEGIES

The next section gives a quick rundown of RM waste management procedures with an emphasis on recycling, usage, and material recovery. Numerous commercial and industrial activities, including those involving design & construction materials, cement, concrete, colored pencils agencies for wants to paint, paper/polymer/ceramic/refractory goods, catalyst supports, inorganic compounds, adsorbent materials, metallurgical recovery of metals (Al, Ti, Si), rare earth elements, and many others, have attempted to recycle significant amounts of RM.

Construction Materials- A number of nations have conducted in-depth studies on the use of RM in the manufacture of cement. One of the best uses of RM is said to be in road construction. High levels of iron and aluminum in RM have reportedly been found to speed up the clinkering processes and replacing slag in the cement manufacturing. The strength and durability of various types of bricks, including hollow bricks, fly ash bricks, decorative bricks, and non-fired, non-steam cured bricks, were found to be quite directly analogous to standard bricks by a number of researchers who looked into the prospective recycling of RM for design and construction supplies.By combining RM with clay and/or fly ash, stable blocks with the strength of classes II/III bricks have been created. Low density (1.1-1.2 g/cm3), hollow bricks and blocks were also created.

Utilization of RM in the creation of glass-ceramics, geopolymers, catalysts, and fillers are a few other applications. RM and limestone mixtures are fired at 1150 to 1200 °C. To substitute Cementitious materials in ceramics and composites applications, combinations of RM with fly ash and other wastes, such as FeNi slag, rice husk ash, blast furnace slag, etc., have been used to create geopolymer paste and synthesized alumino-silicates. Defense, aerospace, petrochemical, and marine industry all frequently use produced great.

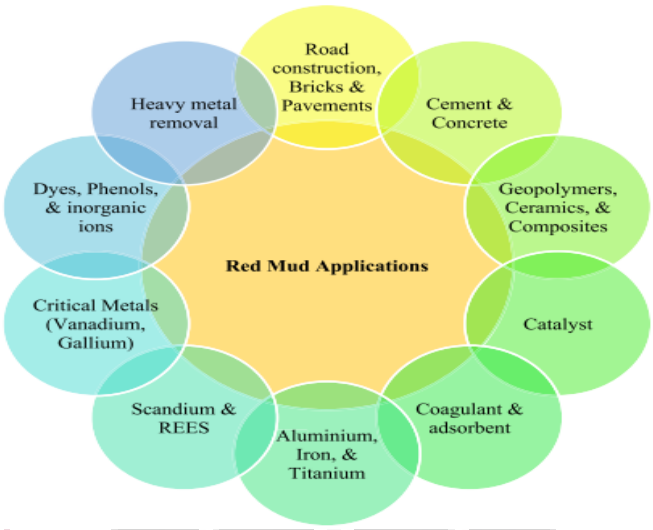

Figure 2 Application of Red Mud

Resource Recovery of MetalsThe content of red mud can vary greatly depending on the geography and locality, the type of bauxite, and the Bayer processes operating conditions. Fe2O3, Al2O3, TiO2, SiO2, Na2O, CaO, and other oxides are important components of RM. There may also contain small elements in ppm levels of U, Ga, V, Zr, Sc, Cr, Mn, Y, Ni, Zn, Th, and rare earths. Up to 90% of RM particles have crystallite size smaller than 75 m, are typically fine-grained, and have surface features among 10 and 30 m2/g. Processing RM can be fairly difficult technologically due to its complex constitution, tiny various particle, water holding capacity, and hazardous caustic-corrosive character.

Iron Recovery from Red Mud -Important Methods One of the main components of RM is iron, which is frequently found as oxides or oxyhydroxides. Iron-bearing phases can be separated and recovered using a variety of processes, including membrane separation, carbothermal reductions, microwaves carbothermal reduction, smelter reduction, acidic leach, and hydrothermal procedures.

IV. Conclusion

Numerous research have been conducted on the use of red mud in the production of various industrial goods, including ceramic tiles, bricks, cement, and land reclamation. This essay examines red mud's use in general. This report also examined Red Mud's function in the construction industry. Additionally, we have supplied a literature review of many researchers working in the construction industry. The next section gives a quick rundown of RM waste disposal procedures with an emphasis on recycle, usage, and reusing materials. Large amounts of RM have been tried to be recycled in a number of commercial and industrial applications.

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